(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 March 2001 (15.03.2001)

PCT

(10) International Publication Number
WO 01/19106 A1

(51) International Patent Classification[7]: H04Q 7/30, H04B 7/26

(21) International Application Number: PCT/GB00/03412

(22) International Filing Date:
5 September 2000 (05.09.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
9921008.0 6 September 1999 (06.09.1999) GB

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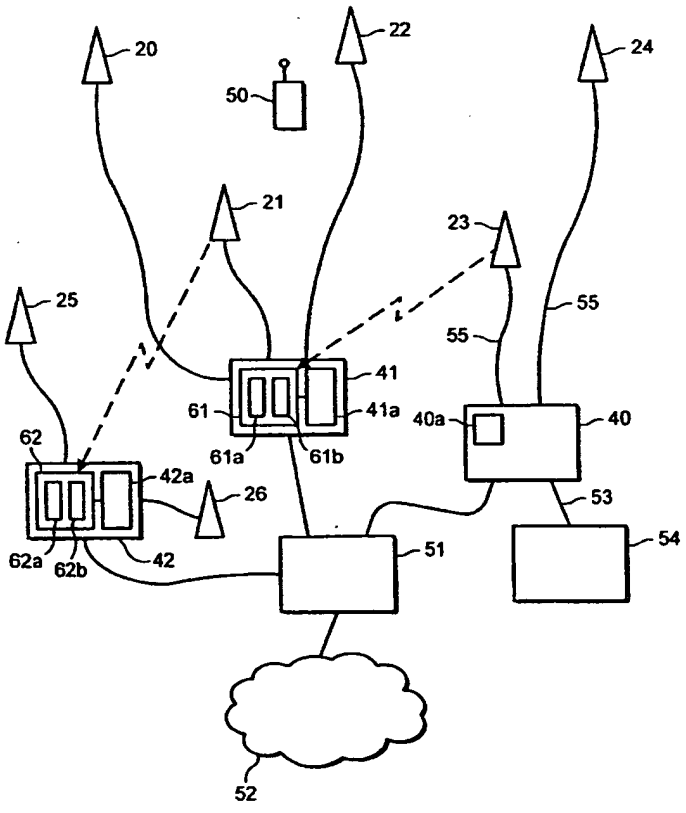
[Continued on next page]

(54) Title: NETWORK FREQUENCY SETTING



(57) Abstract: A frequency setting unit for a radio telecommunications network comprising a first, reference base station transmitting signals at a first frequency, and a second base station transmitting at a second frequency; the frequency control unit comprising: a radio receiver for receiving signals from the first base station; analysis apparatus for analysing the received signals to determine the first frequency; and feedback apparatus responsive to the decoding apparatus and coupled to the second base station for adjusting the second frequency with the aim of establishing a desired relationship between the second frequency and the first frequency.

WO 01/19106 A1

(81) **Designated States** *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) **Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

Interna[illegible]pplication No
PCT/GB 00/03412

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/30 H04B7/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 448 570 A (TODA YASUSHI ET AL) 5 September 1995 (1995-09-05) column 2, line 26 -column 3, line 7 column 4, line 29 - line 57	1,5,7, 10-12,14
X	WO 94 18764 A (AT & T WIRELESS COMMUNICAT ;BEESLEY GRAHAM EDGAR (GB)) 18 August 1994 (1994-08-18) page 6, line 19 -page 7, line 30 page 7, line 35 -page 8, line 11	1-5,10, 11,14
X	US 5 613 211 A (MATSUNO KEISHI) 18 March 1997 (1997-03-18) column 6, line 44 -column 7, line 2 column 10, line 22 - line 36	1,2,5, 10-12,14

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
30 October 2000	06/11/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Dionisi, M

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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

...formation on patent family members

Intern... Application No
PCT/GB 00/03412

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5448570 A	05-09-1995	JP 3052030 B	12-06-2000
		JP 6276126 A	30-09-1994
		JP 3062981 B	12-07-2000
		JP 6276164 A	30-09-1994
WO 9418764 A	18-08-1994	AU 6007594 A	29-08-1994
		DE 69420548 D	14-10-1999
		DE 69420548 T	23-12-1999
		EP 0683944 A	29-11-1995
US 5613211 A	18-03-1997	JP 7255082 A	03-10-1995
		CA 2107606 A	08-04-1994
		EP 0592209 A	13-04-1994
		JP 7283772 A	27-10-1995
		US 5537685 A	16-07-1996

NETWORK FREQUENCY SETTING

This invention relates to setting an operating frequency in a network. The network could be a wireless telecommunications network such as a cellular radio network.

Figure 1 shows schematically the configuration of a typical wireless cellular telecommunications network. The network comprises a number of base-stations (BSs) 1, 2, 3 etc. Each base-station has a radio transceiver capable of transmitting radio signals to and receiving radio signals from the area of an associated cell 4, 5, 6. By means of these signals the base-stations can communicate with a terminal 9 which may be a mobile station (MS) in the associated cell. That terminal itself includes a radio transceiver. Each base station is connected via a base station controller (BSC) 7 to a mobile switching centre (MSC) 8, which is linked in turn to the public telephone network (PSTN) 10. By means of this system a user of the mobile station 9 can establish a telephone call to the public network 10 via the base station in whose cell the mobile station is located. The location of the terminal 9 could be fixed (for example if it is providing radio communications for a fixed building) or the terminal could be moveable (for example if it is a hand portable transceiver or "mobile phone").

In networks that operate according to the GSM (Global System for Mobile communications) standard base stations must maintain a relative frequency accuracy of 5×10^{-8} on the air interface between them and mobile stations. One way to achieve this accuracy would be to provide a highly accurate clock at each base station. However, clocks of the required accuracy would generally be too expensive for this approach to be economical.

In commercial networks the normal solution is to implement a single central highly accurate reference clock (11 in figure 1) for the network. A clock signal from this clock is then conveyed as a pulse train (illustrated at 12) along the national telephone backbone, and then along the GSM infrastructure (via the MSC and the

BSC) to each base station. The central reference clock typically has a relative frequency stability of 10^{-11} over 24 hours. However, the transmission chain to a base station can be long, and this introduces jitter and wander in the clock signal as received by the base station. The base station typically relies on receiving the signal with an accuracy of 1.5×10^{-8} at its 2 MBit/s PCM (pulse code modulated) Abis interface. The transcoder inside the base station typically has a 16 MHz clock (divided down to 2 MHz). This is phase locked to the received PCM clock pulses, jitter and wander above 2 Hz is filtered out, and the signal is averaged over a period of approximately 15 minutes. Having been cleaned in this way the 2 MHz clock signal has an improved accuracy and serves as a reference clock for a 26 MHz clock for the base station. All frequencies and timing on the air/radio interface of the base station are ultimately derived from this 26 MHz clock.

This method has a number of drawbacks. First, it relies on there being a continuous stream of pulses to the base station. If the network carrying the pulses fails then the frequency transmission chain from the fixed network to the base station is broken and accurate synchronisation of the radio network is lost. Also, if part of this transmission chain to the base station runs across a non-clocked network then there may be very significant jitter in the pulse train received at the base station. This is a particular concern for systems where the radio network is integrated with a packet-based network such as the internet or an intranet, which is used to carry traffic between the base station and the external telephone network. One example of such a system is the WIO/GIO (Wireless Intranet Office/GSM Intranet Office) system under development by the applicant. In that system it has been proposed that the BSC should be implemented as a distributed unit, with its components being interconnected over an IP (internet protocol) based network such as a company's intranet. IP-based protocols may then be used for all communications, for instance by employing the H.323 protocol for transmission of speech, and signalling. IP networks are not clocked since they operate asynchronously, and accordingly transmission times are highly variable and unpredictable. The components of the proposed WIO/GIO system that are most important in the present context are the A-gateway to the MSC and the IMC

(Intranet Mobile Clusters) which each connect to one base station with a PCM or HDSL (High bit-rate Digital Subscriber Line) link, since these would conventionally be expected to be used for transmission of the PCM clock pulses to the base stations. Transmission and network access times are highly variable and unpredictable on IP networks. On a single LAN, transmission times typically are below 10 ms in low traffic situations. In an extensive intranet, transmission times can be higher. Access times are always negligible if the network is not congested. Providing additional cables for carrying a clock signal works against the primary reason for using the intranet: making better use of an existing network.

There is therefore a need for a system that allows base stations to be synchronised to a desired degree of accuracy without the disadvantages of the approaches described above.

According to one aspect of the present invention there is provided a frequency setting unit for a radio telecommunications network comprising a first, reference base station transmitting signals at a first frequency, and a second base station transmitting at a second frequency; the frequency control unit comprising: a radio receiver for receiving signals from the first base station; analysis apparatus for analysing the received signals to determine the first frequency; and frequency setting apparatus responsive to the decoding apparatus and coupled to the second base station for adjusting the second frequency with the aim of establishing a desired relationship between the second frequency and the first frequency.

According to a second aspect of the invention there is provided a telecommunications network comprising such a frequency setting unit.

According to a third aspect of the present invention there is provided a method for frequency setting in a wireless telecommunications network comprising a first, reference base station transmitting signals at a first frequency, and a second base station transmitting at a second frequency; the method comprising the steps of:

receiving signals from the first base station; analysing the received signals to determine the first frequency; and adjusting the second frequency with the aim of establishing a desired relationship between the second frequency and the first frequency.

Suitably, in consequence of the said frequency adjustment operation the second base station correspondingly transmits on the second frequency with an accuracy in frequency corresponding to the accuracy in frequency of the first base station. This may provide a convenient means to allow the second base station to transmit within required specifications of accuracy of frequency.

The said signals from the first base station may be broadcast signals. The said signals suitably include a repeated feature that may be identified by the analysis apparatus to determine the first frequency.

The second base station may comprise a clock whose frequency is set by means of the frequency setting apparatus. The clock may be set by means of a clock setting signal from the frequency setting apparatus. The clock setting signal may signal the clock to be advanced or retarded or may comprise a clock pulse train to which the clock's frequency is matched. The frequency setting apparatus is suitably capable of sending such a signal to the second base station.

The first base station and the second base station may be of the same radio telecommunications network or of different radio telecommunications networks.

The frequency setting unit is preferably comprised in a unit capable of performing base station controller functions for the second base station. This is most preferably a base station controller of the second base station. An antenna for the receiver may be located remotely from the said base station controller for reception of signals transmitted by the first base station.

The present invention provides particular benefit when the second base station is connected to another telecommunications network by means of a connection that is at least in part asynchronous, employing for example an internet protocol at some point between the second base station and the interface to that other network. The link for voice or data traffic and/or signalling between the second base station and its base station controller may be an asynchronous connection. In that case an additional synchronous connection may be provided between the two for carrying clock setting signals from the frequency setting unit.

The network of which the second base station is part may be operable according to the GSM (Global System for Mobile communications) standard or a derivative thereof, or another standard. The network is preferably a cellular telephony network.

The said desired relationship is suitably a predetermined desired relationship. The relationship is preferably such that the first frequency and the second frequency are equal, but alternatively the relationship may be such that the first frequency and the second frequency are offset by a desired and/or predetermined amount, or that the first frequency is a predetermined multiple of the second frequency. The said multiple may be greater than or less than unity.

The system of the invention preferably operates to establish the said desired relationship. The system most preferably operates with the aim of maintaining, or to maintain, that relationship.

The present invention will now be described by way of example with reference to the accompanying drawing, in which:

figure 2 shows a schematic diagram of part of a cellular telephone network incorporating a frequency setting system; and

figure 3 shows a schematic diagram of part of a cellular network capable of, at least in part, employing asynchronous signalling and incorporating a frequency setting system.

The system shown in figure 2 is structurally similar to that shown in figure 1. The system of figure 2 comprises base stations 20-26, each of which has a radio transceiver capable of transmitting radio signals to and receiving radio signals from the area of an associated cell. By means of these signals the base stations can communicate with a terminal 50 (which may comprise or be a mobile telephone or suitably modified mobile telephone) in the associated cell. That terminal itself includes a radio transceiver. Each base station is connected by a synchronous link to its respective base station controller (BSC) 40, 41, 42, and via the respective BSC to a mobile switching centre (MSC) 51, which is linked in turn to the public telephone network (PSTN) 52.

The system of figure 2 includes several BSCs which control respective groups ("clusters") of base stations. One of the BSCs, BSC 40, is connected by a synchronous fixed wire link 53 to a highly accurate reference clock 54. A clock pulse train from the clock 54 is sent to the BSC 40 along the link 53. This clock pulse train is used by the BSC to derive a set of clock pulse trains that are sent by a frequency setting unit 40a in the BCS 40 over the respective synchronous links 55 to the base stations 23, 24 that are under the control of the BSC 40. In this way the frequency at which those base stations is set accurately.

The base stations 23, 24 thus transmit signals at an accurately set frequency that is derived precisely from the frequency of the reference clock 54. According to the present embodiment of this invention, those transmitted signals are used to accurately set the frequencies of the clocks of the other base stations 21 etc. of the system. The BSC 40 acts as an initial reference BSC and the base stations 23, 24 under its control act as initial reference base stations. The accurately set frequency of those base stations is passed to other base stations of the network, cascading from base stations under the control of BSCs that may be termed as "higher" in a frequency-setting hierarchy on to those that are under the control of "lower" BSCs. This process will be described in more detail below.

Each BSC 41, 42 lower in the hierarchy than the reference BSC 40 has a synchronisation unit 61, 62. Each synchronisation unit includes a radio receiver 61a, 62a and a radio analysis unit 61b, 62b. The synchronisation units could be based on conventional mobile handsets with suitable modifications, such as for example a higher timing accuracy. The synchronisation units are coupled to the frequency setting units 41a, 42a of their respective base stations, which generate frequency setting signals for the relevant base stations in dependence on signals received from the synchronisation units 61, 62. The network is planned so that the radio receiver of the synchronisation unit of each BSC is located (or at least has an antenna that is located) where it can receive radio transmissions from a base station that is under the control of a BSC that is higher in the hierarchy than the BSC to which the radio receiver is attached. In the system shown in figure 2 BSC 41 is lower in the hierarchy than the reference BSC 40, and BSC 42 is lower still. The receiver 61a of BSC 41 is located in the coverage area of base station 23, which is under the control of BSC 40. The receiver 62a of BSC 42 is located in sufficiently near base station 21, which is under the control of BSC 41, to be able to receive signals from it at sufficient accuracy to determine their frequency.

Each synchronisation unit is capable of detecting an appropriate signal (e.g. the BCCH signal in a GSM-type network) and synchronising to it in the same way as a conventional mobile station.

To fix the frequency of the clocks of the base stations that are under the control of BSC 41 receiver 61a receives signals from the reference base station 23. These signals are analysed by analysis unit 61b to determine their frequency. The result of this analysis is used by the frequency setting unit 41a to set the frequencies of the base stations 21, 22. This may be done in a number of ways. The BSC 41 could have an internal clock that (e.g. in the frequency setting unit 41) that is set first, with the signals to the base stations 21, 22 being simply derived from that clock. Alternatively, the signals to the base stations 21, 22 could be derived straight from the detected frequency, without the intermediate step of setting the BSC's clock. In either case, the relevant clock could be set in an absolute manner

to match the required derived frequency or a desired multiple of the received frequency by shifting the frequency of the clock of BSC 40 in a direction determined by a measurement of the difference in frequency between it and the received clock frequency. In a preferred method, once the clock of BSC 40 has been set, BSC 40 can send signals to set clocks of the base stations 21, 22 under its control, either in an absolute manner or by frequency shifting. Once the frequencies of the base stations under the control of BSC 40 have been set, the frequencies of the base stations under the control of BSC 41 can be set in an analogous way by means of units 62 and 42a. In a larger network the frequency setting could propagate through the whole network and is effective while the frequency accuracy is maintained during the frequency transfer process.

Figure 3 shows schematically one example of the possible architectures of an IP-network-based cellular architecture. As in the more conventional cellular system described above, the system includes sets of base stations 100-104 under the control of respective IMC (intranet mobile cluster) units 110, 111. The IMC units are linked to a gateway unit (GWU) 120 via which the network as shown can be connected to an external public telephone network 121 for placing and receiving calls, a cellular network 122 for support functions such as address look-up and an IP network 123 which could be a company intranet or the internet for sending and receiving data and placing and receiving calls using protocols such as H.323. In the system of figure 3 the connections between any of the units - for instance between the base stations and the IMCs, between the IMCs and the GWU, or between the GWU and other networks - could be implemented using one or more asynchronous protocols such as internet protocol. Therefore, frequency setting poses a particular problem in the system of figure 3 because of the potential difficulties of conveying clock signals precisely to the base stations.

The frequency setting operation described above in relation to figure 2 could be used in an analogous way in the network of figure 3. The setting functions performed by the BSCs in the system of figure 2 could be performed by the IMC units in the system of figure 3. As shown in figure 3, synchronisation units 112,

113, each comprising a receiver 112a, 113a and an analysis unit 112b, 113b, and frequency setting units 110a, 111a could be provided for setting the frequencies of the base stations 100-104. In the system of figure 3 the reference cluster could be set by a highly accurate reference clock or, as illustrated, one or more clusters in the system of figure 3 could set their frequencies by reference to signals received from an external radio telephone network. In the illustrated embodiment the receiver 113a receives a signal from an overlapping cellular network 124 for synchronisation of base stations 100, 101 and the receiver 112a receives a signal from base station 101 for synchronisation of base stations 102-104. Alternatively, the frequency setting unit 111a could derive its frequency from an accurate reference clock and/or the frequency setting unit 112a could derive its frequency from the network 124.

The system of figure 3 could be configured to operate at a frequency and according to the protocol of a standard radio telephone system such as GSM. In that case it is especially convenient if a reference cluster and/or other clusters in the system of figure 3 receive signals from that external cellular network and use those to set their own frequencies. The practicality of this approach is increased when the coverage of the external cellular network overlaps that of the IP-network-based system so that receivers for receiving signals from the external cellular network do not need to be remote from the IP-network-based system.

In view of the typical architecture of a BSC and the anticipated architecture of a commercial implementation of an IMC the frequency analysis unit could be provided on an expansion card for a BSC or IMC. If appropriate the receiver unit could be provided on the same card or could be connected remotely via a cable link.

It is possible for the receiver and/or frequency analysis units to be provided in or at a base station. The relevant frequency setting signals could be passed from there to other base stations of its cluster via its BSC/IMC, or each base station could have its own receiver and analysis unit. However, for several reasons this

latter approach is unlikely to be preferred. Adding such hardware to a base station would increase the costs of the base station, which would not be justified if the base station were deployed in the conventional way, i.e. connected to a clock feeding PCM or HDSL line. And the IMC/BSC might need an especially accurate direct link to the received clock signals to perform its BSC/IMC functions. Also, it is likely to be easier to arrange that the additional radio receiver is not overloaded by the relatively high-power radio output of the internal antenna of a base station if it is not located at a base station.

Since the accurate clock signal generated in the IMC/BSC is used as a reference clock signal for the base station, the base station itself thus only needs a relatively inexpensive clock. For example, it may be possible to use a clock of the type used in a typical mobile phone if the signalling between the IMC/BSC and the base station were adequate.

The clock signal could be sent from the IMC/BSC to the base station as a 2 MHz pulse train.

It is possible that the IMC and the base station may be connected by an asynchronous link such as a USB. (Such a link is illustrated at 130 between IMC 110 and base station 104 in figure 3). In that case a dedicated cable 131 should be provided to carry clock pulses to the base station. If the IMC/BSC and the base station are already connected by a link that supports PCM then an extra cable might not be needed. For instance, the HSCSD PC expansion card normally used could receive its clock feed through a cable (which may or may not be an additional cable) connected to the reference clock expansion card of either solution. The clock signal can then be transmitted over the Abis interface as usual. If the base station presents a separate clock input interface, then a dedicated clock cable can again be used. Since the base station then does not have to derive the clock signal from the PCM pulses, a less accurate reference clock signal is necessary to meet the given accuracy specification for the base

station. An accuracy of 2×10^{-8} to 3×10^{-8} is estimated to be sufficient, instead of 1.5×10^{-8}.

At the IMC/BSC the receiver/analysis hardware may be combined with the interface hardware for the link to the base station(s) or may be implemented separately.

In order for the receiver/analysis hardware to correctly pick up the required frequency for the clock control method there should be knowledge of the frequency it is to detect. Thus it or the IMC/BSC in which it is installed may store a list of the frequencies and identifiers (BSICs) used by all or nearby base stations of its network. With this knowledge it could detect and analyse the frequencies of more than one base station, for extra accuracy or to allow for fail-safe redundancy. The list may also include information on base stations from other networks if their transmissions are to be used for frequency setting too. In practice, the list could be stored centrally (e.g. in GWU 120) and sent to the receiver/analysis unit as required. Forbidden carriers can be added manually to the list, for example if there is strong coverage from another system.

When the receiver/analysis hardware is to detect a frequency it searches for the strongest suitable carrier signal (preferably a broadcast signal such as the BCCH signal in a GSM-type network) and continuously receives and decodes synchronisation bursts. This provides a reference clock to the receiver unit's internal oscillator. The receiver unit may measure the frequency/timing of the received signal using the "time-base counter" principle, according to which the TDMA frame number (e.g. of a GSM transmission), timeslot number and number of the 1/4 bit are followed in accordance with GSM specification 05.10. The carrier signal may be one from an external network, which is not used in the system implementing the frequency measurement. Of course, analogous principles may be used in networks operating according to other standards, including non-TDMA standards.

If the receiver/analysis unit is unable to receive satisfactorily from the location of its IMC/BSC then an external antenna can be provided to improve the reception quality to that needed for reliably reading the frequency. For instance, in a GSM-type system the receiver needs only to be capable of accurately receiving synchronisation bursts.

The accuracy of this reference clock signal received by the receiver/analysis unit over the air interface is about the same as the serving base station's under good radio conditions. If the clock of the serving base stations is running more precisely than the relevant specification calls for then there may even be significant room for loss of accuracy over the air interface due to non-ideal radio conditions.

If the receiver/analysis unit loses the signal it is receiving then it preferably searches for another suitable carrier. The base stations that rely on the receiver/analysis unit should have sufficiently stable clocks to cope with a short break in the clock signals they receive from the IMC/BSC in order to be able to deal with a short interruption of this nature and still stay within the specified tolerance. One approach to increase the stability of the system under these conditions is to provide an additional clock at the IMC/BSC for supporting the base stations when the receiver/analysis unit loses signal or fails. This may be more economical than providing a more accurate clock at every base station. If the base stations were to provide support for interruptions to the clock pulses then in a GSM system their clocks should exceed the accuracy of 0.05ppm demanded by GSM specifications for the carrier frequency.

For additional accuracy, the receiver of the receiver/analysis unit could be capable of detecting the frequency of more than one base station, for example six base stations. If one of the detected base stations is one whose frequency is to be set by means of that very receiver/analysis unit then there may be a feedback loop whereby the clock of the base station may be accurately advanced or retarded to

match or otherwise be set in accordance with a desired ratio relative to the frequency of another base station whose signals are received.

As the network is started up it is possible for each base station to transmit only on its broadcast (e.g. BCCH) channel until all transmission frequencies have reached sufficient accuracy in frequency, or frequency equalisation has been established, and only then to begin use of its traffic channels.

As an example of the time span needed to achieve synchronisation, the required accuracy in GSM is 0.05 PPM, which corresponds to 3 μs/min. In GSM the bit duration is 3.7 μs so the duration of a quarter bit is 0.9 μs. This allows in theory an accuracy of 0.015 PPM to be achieved using the information gathered over a minute. Taking errors into account (for instance inaccuracies in the clocks at base stations and/or IMCs/BSCs) it would be expected that this one minute period should be sufficient to achieve sufficient accuracy in frequency in accordance with the accuracy requirements of the GSM standard.

The present invention may include any feature or combination of features disclosed herein either implicitly or explicitly or any generalisation thereof irrespective of whether it relates to the presently claimed invention. In view of the foregoing description it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention.

CLAIMS

1. A frequency setting unit for a radio telecommunications network comprising a first, reference base station transmitting signals at a first frequency, and a second base station transmitting at a second frequency; the frequency control unit comprising:

a radio receiver for receiving signals from the first base station;

analysis apparatus for analysing the received signals to determine the first frequency; and

frequency setting apparatus responsive to the decoding apparatus and coupled to the second base station for adjusting the second frequency with the aim of establishing a desired relationship between the second frequency and the first frequency.

2. A frequency setting unit as claimed in claim 1, wherein the said signals from the first base station are broadcast signals.

3. A frequency setting unit as claimed in claim 1 or 2, wherein the second base station comprises a clock and the frequency setting apparatus is capable of transmitting a clock setting signal to the second base station for setting the clock.

4. A frequency setting unit as claimed in claim 3, wherein the clock setting signal comprises a stream of clock pulses.

5. A frequency setting unit as claimed in any preceding claim, wherein the first base station and the second base station are of the same radio telecommunications network.

6. A frequency setting unit as claimed in any preceding claim, wherein the first base station and the second base station are of different radio telecommunications networks.

7. A frequency setting unit as claimed in any preceding claim, comprised in a unit capable of performing base station controller functions for the second base station.

8. A frequency setting unit as claimed in any preceding claim, wherein the second base station is connected to another telecommunications network by means of an asynchronous connection.

9. A frequency setting unit as claimed in claim 8, wherein the asynchronous connection is an internet protocol connection.

10. A frequency setting unit substantially as herein described with reference to figures 2 or 3 of the accompanying drawings.

11. A telecommunications network comprising the said second base station and a frequency setting unit as claimed in any of claims 1 to 10.

12. A telecommunications network as claimed in claim 11 operable according to the GSM (Global System for Mobile communications) standard or a derivative thereof.

13. A telecommunications network as claimed in claim 11 or 12, including an interface to another network and a connection between the second base station and that interface that is at least in part asynchronous.

14. A method for frequency setting in a wireless telecommunications network comprising a first, reference base station transmitting signals at a first frequency, and a second base station transmitting at a second frequency; the method comprising the steps of:

receiving signals from the first base station;

analysing the received signals to determine the first frequency; and

adjusting the second frequency with the aim of establishing a desired relationship between the second frequency and the first frequency.

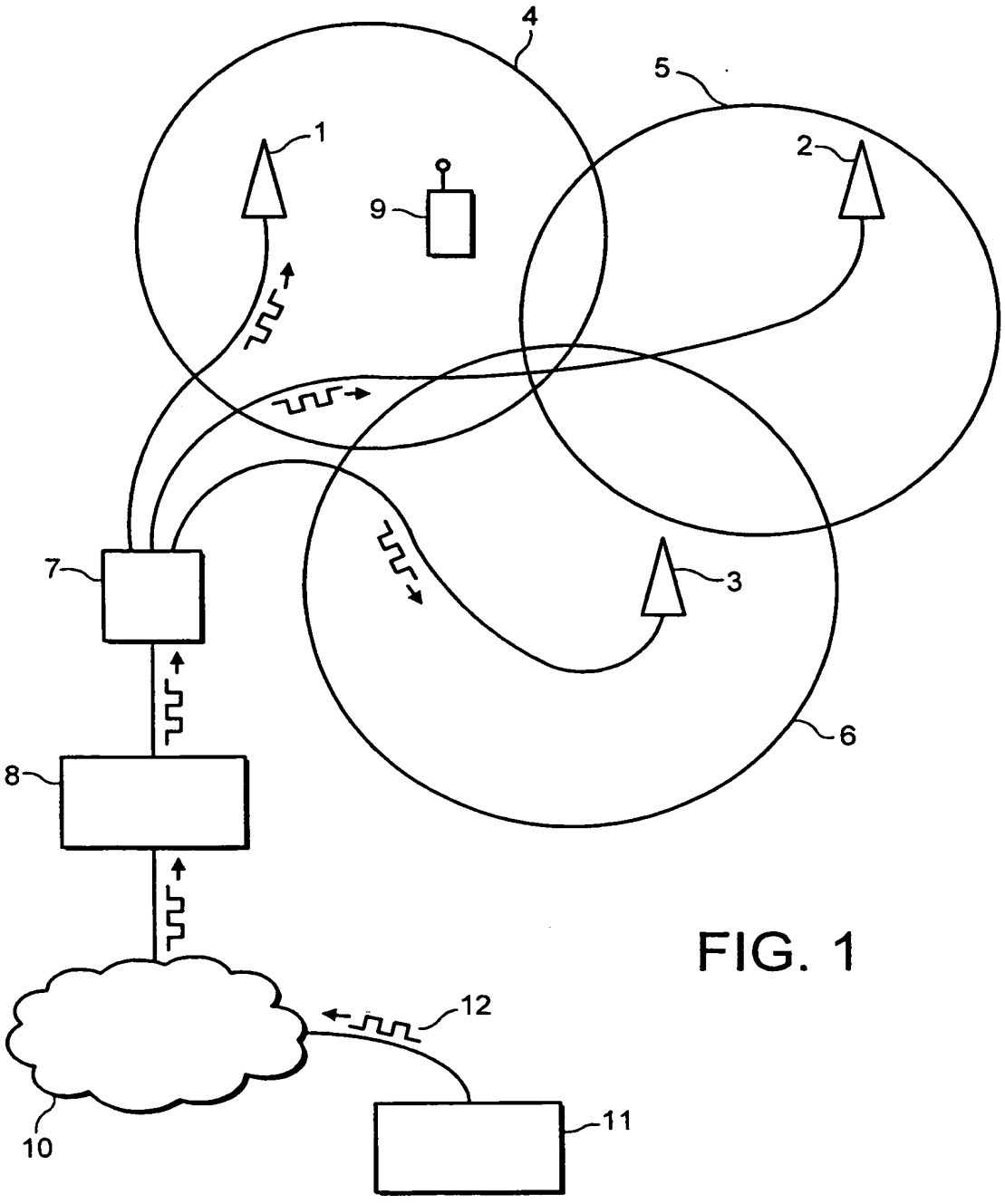
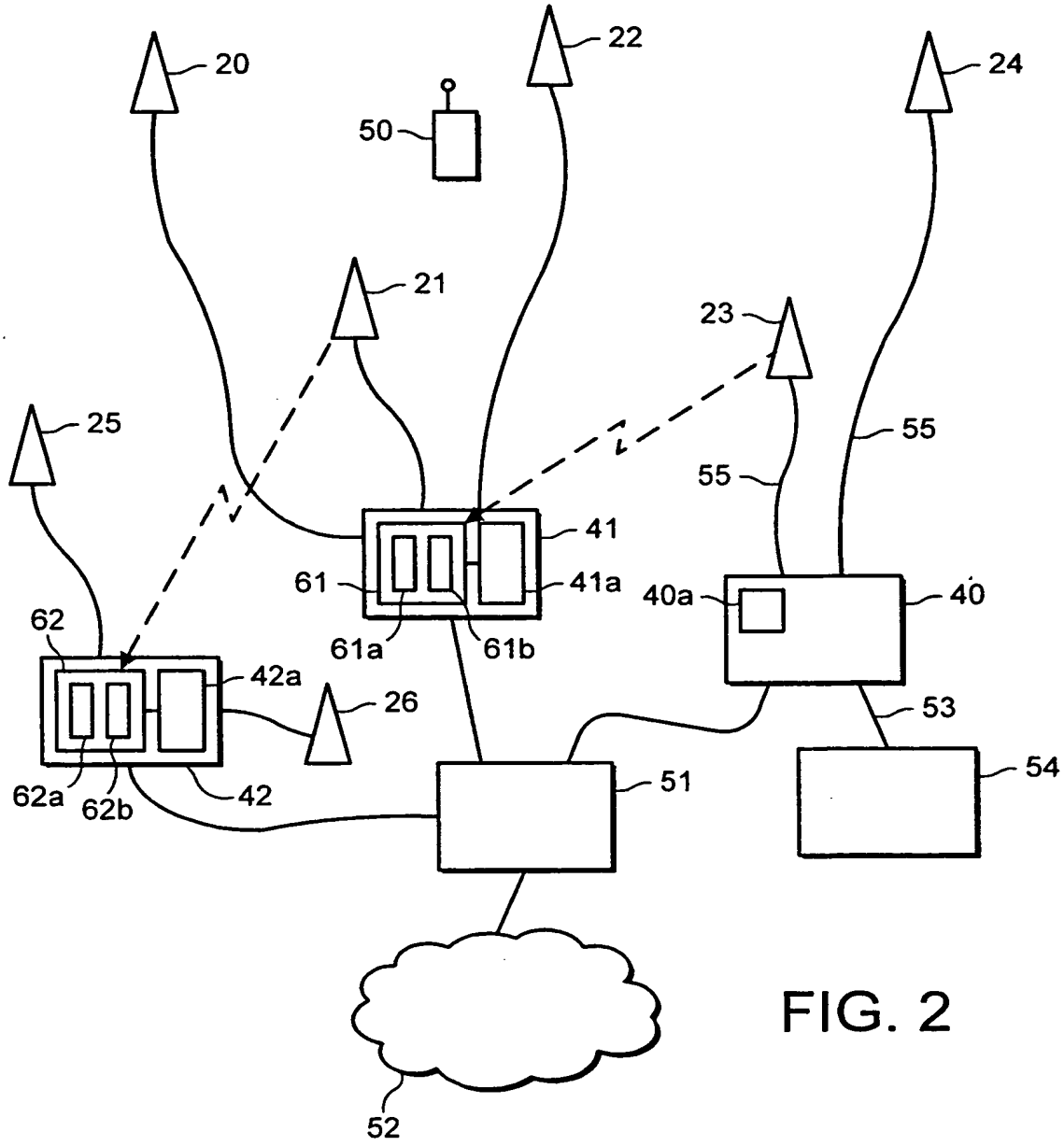


FIG. 1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40a
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61a
61b
42a
26
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62a
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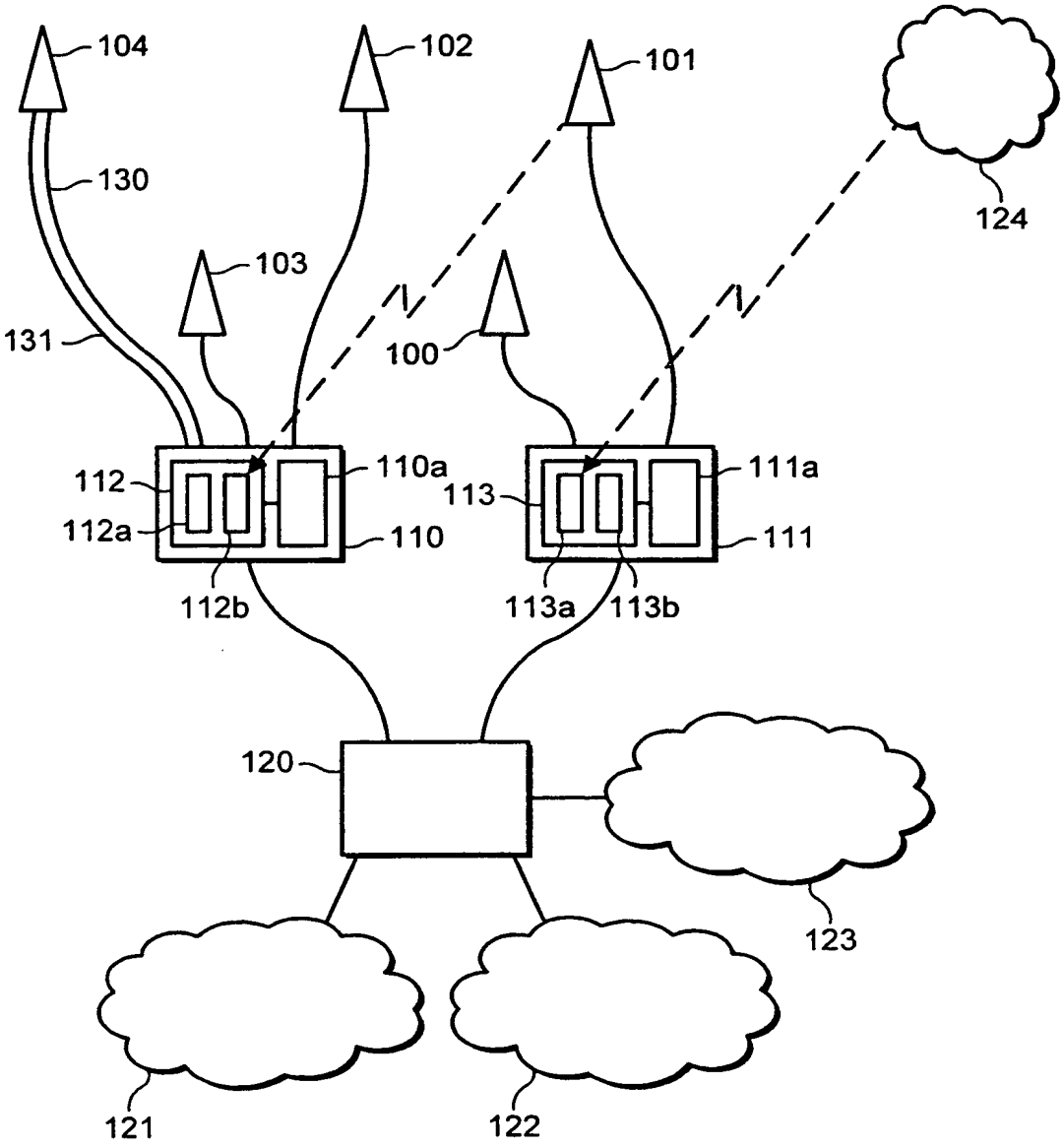
FIG. 2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130
124
103
131
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111a
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113b
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122

FIG. 3

INTERNATIONAL SEARCH REPORT

Internat application No
PCT/GB 00/03412

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/30 H04B7/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 448 570 A (TODA YASUSHI ET AL) 5 September 1995 (1995-09-05) column 2, line 26 -column 3, line 7 column 4, line 29 - line 57	1,5,7, 10-12,14
X	WO 94 18764 A (AT & T WIRELESS COMMUNICAT ;BEESLEY GRAHAM EDGAR (GB)) 18 August 1994 (1994-08-18) page 6, line 19 -page 7, line 30 page 7, line 35 -page 8, line 11	1-5,10, 11,14
X	US 5 613 211 A (MATSUNO KEISHI) 18 March 1997 (1997-03-18) column 6, line 44 -column 7, line 2 column 10, line 22 - line 36	1,2,5, 10-12,14

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 October 2000	06/11/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Dionisi, M

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

...formation on patent family members

Intern... ...pplication No
PCT/GB 00/03412

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5448570 A	05-09-1995	JP 3052030 B	12-06-2000
		JP 6276126 A	30-09-1994
		JP 3062981 B	12-07-2000
		JP 6276164 A	30-09-1994
WO 9418764 A	18-08-1994	AU 6007594 A	29-08-1994
		DE 69420548 D	14-10-1999
		DE 69420548 T	23-12-1999
		EP 0683944 A	29-11-1995
US 5613211 A	18-03-1997	JP 7255082 A	03-10-1995
		CA 2107606 A	08-04-1994
		EP 0592209 A	13-04-1994
		JP 7283772 A	27-10-1995
		US 5537685 A	16-07-1996

CLAIMS

1. A frequency setting unit for a radio telecommunications network comprising a first, reference base station transmitting signals at a first frequency, and a second base station transmitting at a second frequency; the frequency control unit comprising:

a radio receiver for receiving signals from the first base station;

analysis apparatus for analysing the received signals to determine the first frequency; and

frequency setting apparatus responsive to the decoding apparatus and coupled to the second base station for adjusting the second frequency with the aim of establishing a desired relationship between the second frequency and the first frequency.

2. A frequency setting unit as claimed in claim 1, wherein the said signals from the first base station are broadcast signals.

3. A frequency setting unit as claimed in claim 1 or 2, wherein the second base station comprises a clock and the frequency setting apparatus is capable of transmitting a clock setting signal to the second base station for setting the clock.

4. A frequency setting unit as claimed in claim 3, wherein the clock setting signal comprises a stream of clock pulses.

5. A frequency setting unit as claimed in any preceding claim, wherein the first base station and the second base station are of the same radio telecommunications network.

6. A frequency setting unit as claimed in any preceding claim, wherein the first base station and the second base station are of different radio telecommunications networks.

7. A frequency setting unit as claimed in any preceding claim, comprised in a unit capable of performing base station controller functions for the second base station.

8. A frequency setting unit as claimed in any preceding claim, wherein the second base station is connected to another telecommunications network by means of an asynchronous connection.

9. A frequency setting unit as claimed in claim 8, wherein the asynchronous connection is an internet protocol connection.

10. A frequency setting unit substantially as herein described with reference to figures 2 or 3 of the accompanying drawings.

11. A telecommunications network comprising the said second base station and a frequency setting unit as claimed in any of claims 1 to 10.

12. A telecommunications network as claimed in claim 11 operable according to the GSM (Global System for Mobile communications) standard or a derivative thereof.

13. A telecommunications network as claimed in claim 11 or 12, including an interface to another network and a connection between the second base station and that interface that is at least in part asynchronous.

14. A method for frequency setting in a wireless telecommunications network comprising a first, reference base station transmitting signals at a first frequency, and a second base station transmitting at a second frequency; the method comprising the steps of:

receiving signals from the first base station;

analysing the received signals to determine the first frequency; and

adjusting the second frequency with the aim of establishing a desired relationship between the second frequency and the first frequency.

PATENT COOPERATION TREATY

PCT

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
102785/PRS		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/03412	05/09/2000	06/09/1999
International Patent Classification (IPC) or national classification and IPC H04Q7/30		
Applicant NOKIA NETWORKS OY et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
05/04/2001	18.12.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Oteo Mayayo, C Telephone No. +49 89 2399 7563

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/03412

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-13 as originally filed

Claims, No.:

1-17 with telefax of 04/12/2001

Drawings, sheets:

1/3-3/3 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-17
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-17
Industrial applicability (IA)	Yes:	Claims	1-17
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

1. Concerning Item I

Basis of the opinion

Reference is made to the following document:

D1: US-A-5 448 570 (TODA YASUSHI ET AL) 5 September 1995 (1995-09-05)

2. Concerning Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

2.1 The document D1 is regarded as being the closest prior art to the subject-matter of **claim 17**, and insofar as this claim can be understood (see Section VIII), this document shows the following features thereof (the references in parentheses applying to this document):

(i) A method for frequency setting in a wireless telecommunications network such that base stations transmit at an accurately set frequency derived from a reference signal (see D1, column 7, lines 63-65: "A method for establishing mutual synchronization among base stations in a communication system..."), said network comprising a first, reference base station (see D1, column 2, lines 45-49: "master base station") controlled by a controller (see D1, column 2, lines 45-49: "central station") transmitting signals at a first frequency, and a second base station (see D1, column 2, lines 45-49: "...base station close to the master base station...") controlled by a controller (see D1, column 2, lines 45-49: "central station") and transmitting at a second frequency; the method comprising the steps of:

(ii) receiving signals from the first base station (see D1, column 4, lines 29-38: "...the base station used in the telephone system includes ... a receiving unit ... for receiving radio signals...");

(iii) analysing the received signals to determine the first frequency (see D1, column 4, lines 42-46: "The control unit ... analyses data received from a

base station designated as a reference base station..."); and

(iv) adjusting the second frequency with the aim of establishing a desired relationship between the second frequency and the first frequency (see D1, column 4, lines 46-49: "The synchronizer synchronizes a radio signal to be transmitted from this station with a radio signal from the reference base station which is received by the receiving unit").

The subject-matter of claim 17 differs from D1 only in that in claim 17 is specified that the first reference base station, controlled by a first controller, transmits at a first frequency and the second base station, controlled by a second controller, transmits at a second frequency, which is not explicitly disclosed in D1.

However, it would be obvious to the person skilled in the art that also in D1 both base stations transmit at two different frequencies, see column 2, lines 49-53: "The instructed base station synchronizes its own radio signal with the radio signal from the master base station...". The fact that in claim 17 there are two different controllers controlling different groups of base stations (first and second controller) is common practice for the person skilled in the art of telecommunication networks, when the number of base stations to control increase in the network.

Thus, the subject-matter of **claim 17** lacks an inventive step and does not meet the requirements of Article 33(3) PCT.

2.2 Independent **claim 1** contains in terms of apparatus features (a frequency setting unit) all the features of claim 17, therefore, the subject-matter of claim 1 does not involve an inventive step in the sense of Article 33(3) PCT (see point above).

2.3 Dependent **claims 2 to 16** do not contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the Article 33(3) PCT in respect of inventive step, since they are merely one of several straightforward possibilities from which the skilled person would select, in accordance with circumstances, without the exercise of inventive skill, in order to implement the system of claim 1.

2.4 The present invention is **susceptible of industrial application**, Article 33 (4) PCT.

3. Concerning Item VII
Certain defects in the international application

Each independent claim should have been drafted in the proper two-part "characterised" form recommended by Rule 6 PCT, having a preamble that correctly reflects the nearest prior art, presumably that represented by document D1.

The opening part of the description should have been brought into conformity with the wording of the claim of broadest scope as finally amended.

All the claims should have included reference signs in parentheses where features shown in the drawings are referred to (Rule 6.2 (b) PCT) (see section VIII, point 4.2, for a clarity problem due to the lack of some reference signs in claim 1).

4. Concerning Item VIII
Certain observations on the international application

The application does not meet the requirements of Article 6 PCT, because **independent claims 1 and 17** as well as **dependent claim 7** are not clear for the following reasons:

4.1 Independent **claim 1** is unclear because in line 1 "A frequency setting unit" is mentioned, which appears in the description in page 7, line 6: "...the frequency setting units 41a, 42a...". However, in claim 1, line 10 a "frequency setting apparatus (41a)" is mentioned. It is not clear if both refer to the same apparatus, in that case claim 1 would be unclear as well, since it is not possible to have "the frequency setting unit... comprising ... frequency setting unit...".

These two terms "frequency setting unit" and "frequency setting apparatus" should have been clarified, and the adequate reference signs should have been included.

4.2 Furthermore, independent **claim 1** is also unclear since the terms "frequency setting apparatus responsive to the analysis apparatus and coupled to the second base station by means of the second controller". As it is clear from Figure 2, the analysis apparatus (61b) is included in the second controller (41) and, therefore, it can not be coupled to the base station "by means of the second controller", as it belongs to it.

The same unclarity mentioned above arises for dependent **claim 7** in relation to claim 1, as in claim 7 it is specified that the frequency setting unit is comprised in the second controller.

4.3 Independent **claim 17** is unclear, since it is not clear where the three method steps are carried out: "...the method comprising the steps of: receiving signals from the first base station...", etc. It is not clear from the claim 17, where these signals are received. If what was meant was "receiving signals in a radio receiver (61a) from the first base station...", etc. this should have been specified in the claim.

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

SLINGSBY, Philip, Roy
Page White & Farrer
54 Doughty Street
London WC1N 2LS
ROYAUME-UNI

Date of mailing (day/month/year)
17 January 2002 (17.01.02)

Applicant's or agent's file reference
102785/PRS

IMPORTANT NOTIFICATION

International application No.
PCT/GB00/03412

International filing date (day/month/year)
05 September 2000 (05.09.00)

1. The following indications appeared on record concerning:

[X] the applicant [ ] the inventor [ ] the agent [ ] the common representative

Name and Address
NOKIA NETWORKS OY
Keilalahdentie 4
FIN-02150 Espoo
Finland

State of Nationality: FI
State of Residence: FI
Telephone No.:
Facsimile No.:
Teleprinter No.:

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[ ] the person [X] the name [ ] the address [ ] the nationality [ ] the residence

Name and Address
NOKIA CORPORATION
Keilalahdentie 4
FIN-02150 Espoo
Finland

State of Nationality: FI
State of Residence: FI
Telephone No.:
Facsimile No.:
Teleprinter No.:

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

[X] the receiving Office
[ ] the International Searching Authority
[X] the International Preliminary Examining Authority
[ ] the designated Offices concerned
[X] the elected Offices concerned
[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

Authorized officer
S. Buttay
Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 05 June 2001 (05.06.01)	
International application No. PCT/GB00/03412	**Applicant's or agent's file reference** 102785/PRS
International filing date (day/month/year) 05 September 2000 (05.09.00)	**Priority date** (day/month/year) 06 September 1999 (06.09.99)
Applicant KALLIO, Janne et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

05 April 2001 (05.04.01)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Olivia TEFY Telephone No.: (41-22) 338.83.38

Form PCT/IB/331 (July 1992)

GB0003412